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ASSESSMENT OF INTERNAL CURING EFFICIENCY OF PEG-400 THROUGH STRENGTH CHARACTERIZATION OF CONCRETE

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Abstract

Proper curing of concrete is essential for attaining the required strength and longevity of concrete structures. In many construction projects, it's challenging to sustain constant external curing because of limited water supply and adverse environmental factors. Internal curing has become an alternative method to address these limitations. This study examines how effective Polyethylene Glycol-400 (PEG-400) is as an internal curing agent in concrete. Experiments were conducted on both conventional and self-curing concrete, formulated using varying percentages of PEG-4000.5%, 1.0%, 1.5%, and 2.0%based on the weight of cement. For evaluation, two concrete gradesM20 and M30were taken into consideration. Tests for compressive strength and split tensile strength were carried out at 3, 7, and 28 days following curing. The results show that adding PEG-400 enhances moisture retention in the concrete structure and supports adequate strength gain. Of the tested mixtures, the one with 1.5% PEG-400 showed the highest compressive strength, whereas those containing 1.0% PEG-400 performed best in tensile strength. The study verifies that PEG-400 can serve as an effective internal curing agent, lowering reliance on external water curing without compromising the mechanical performance of concrete.

Keywords: *Self-curing concrete, PEG-400, Internal curing, Compressive strength, Split tensile strength, Concrete technology.*

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1. Introduction

Concrete continues to be among the most commonly used construction materials because of its adaptability, wide-spread availability, and strong structural capabilities. Concrete's strength and long-term durability largely rely on proper curing. Traditional curing techniques depend on a steady water supply to maintain adequate hydration of cement particles. However, sustaining these curing conditions is frequently difficult in remote areas, water-poor regions, and large-scale construction efforts.

Internal curing has attracted considerable attention as a method that can deliver moisture directly from within the concrete. In contrast to conventional curing methods, internally cured concrete holds extra water within its matrix, enabling hydration to persist even in the absence of external water. This process helps lower self-desiccation, reduces shrinkage, and enhances the overall quality of hardened concrete.

Polyethylene Glycol (PEG) is among the materials commonly investigated for use in internal curing applications. Because of its ability to retain water, PEG minimizes moisture loss in fresh concrete and aids in the hydration process during the initial phase of strength gain. The effectiveness of PEG relies on various factors, including the grade of concrete, the dosage amount, and the duration of curing. This study aims to assess the mechanical performance of self-curing concrete made using PEG-400.

2. Internal Curing Mechanism and Its Importance

Internal curing involves introducing extra moisture into the concrete to aid cement hydration during the curing phase. Unlike traditional curing, which delivers water from the outer surface, internal curing supplies moisture continuously from within the concrete structure. This method proves especially helpful when external curing is insufficient or hard to sustain.

As cement hydrates, it absorbs water to produce compounds that contribute to strength gain. As concrete hydrates, its internal relative humidity drops, causing self-desiccation and shrinkage. Too much moisture loss can lead to microcracks that negatively impact the durability and lifespan of concrete structures.

Polyethylene Glycol-400 (PEG-400) functions as a moisture-retaining agent, reducing the rate at which water evaporates from concrete. The compound boosts water accessibility in the matrix and ensures ongoing hydration of cement particles. Therefore, internally cured concrete can enhance strength development while minimizing the requirement for extended external curing.

The use of internal curing agents offers several practical advantages, including reduction in curing water demand, improved hydration efficiency, lower shrinkage potential, and better performance under dry environmental conditions. These benefits make self-curing concrete an attractive option for sustainable construction practices.

3. Materials and Experimental Work

3.1 Materials Used

Throughout the investigation, Ordinary Portland Cement (OPC) of 53 grade, meeting applicable Indian Standards, was used as the binding material. The fine aggregate was natural river sand sourced locally, and crushed stone was used for the coarse aggregate. Water suitable for drinking and also appropriate for concrete mixing was used. Polyethylene Glycol-400 (PEG-400) was chosen as the internal curing agent due to its water solubility and ability to retain moisture. Various percentages of PEG-400 were added to the concrete mixtures to assess how it affects their strength properties.

3.2 Concrete Mixes

Two concrete grades, M20 and M30, were formulated for experimental testing. For each grade, standard concrete samples were prepared and evaluated alongside self-curing concrete blends incorporating PEG-400 at 0.5%, 1.0%, 1.5%, and 2.0% of the cement weight. The chosen dosage range was designed to determine the optimal amount of PEG-400 that enhances strength performance while not compromising the characteristics of fresh or hardened concrete.

3.3 Preparation of Specimens

Each component was precisely measured prior to being combined. Cement, fine aggregate, and coarse aggregate were initially mixed in dry form to achieve a consistent blend. Water was then slowly incorporated into the mixture. In the case of self-curing concrete, the necessary amount of PEG-400 was dissolved in the mixing water before being added. Fresh concrete was poured into molds in layers and compacted sufficiently to remove trapped air. For compressive strength testing, 150 mm cube specimens were cast, and for split tensile strength testing, cylindrical specimens with a 150 mm diameter and 300 mm height were prepared. Following casting, the specimens remained undisturbed for 24 hours. Standard concrete samples were cured in water, while self-curing concrete samples were kept in lab conditions without additional curing. Strength tests were conducted at 3, 7, and 28 days.

3.4 Testing Procedure

Compressive strength tests were carried out using a Compression Testing Machine (CTM), following the relevant Indian Standard procedures. The peak load each specimen endured prior to failure was documented and applied in determining its strength. Tensile strength tests were conducted on cylindrical samples using the indirect tensile loading technique. The test involved applying a compressive load along the cylinder's diameter until cracks formed. The recorded values helped assess the tensile strength properties of the concrete mixtures.

4. Results & Discussions

This experiment was conducted to evaluate and compare the mechanical properties of conventional concrete (CC) and self-curing concrete (SCC) formulated using varying proportions of PEG-400. The strength properties were assessed at 3, 7, and 28 days of curing for both M20 and M30 concrete grades.

4.1 Compressive Strength Behaviour

The results for compressive strength showed that, across all concrete mixtures, strength improved as curing age increased. This trend indicates that cement keeps hydrating steadily and the concrete's microstructure develops progressively over time. Among the self-curing mixtures, those with 1.5% PEG-400 showed the greatest compressive strength for both M20 and M30 grades. The enhancement stems from PEG-400's capacity to hold moisture inside the concrete structure, enabling ongoing hydration even without external curing. At lower doses of

PEG-400, the internal moisture available was relatively restricted, but higher doses failed to yield further improvements in strength. As a result, the 1.5% dosage was determined to offer the most balanced performance in terms of compressive strength development. A comparison between standard concrete and the optimal self-curing mix showed that the strength levels attained via internal curing matched those from conventional water curing. This observation suggests that PEG-400 can effectively enhance hydration and promote strength gain in concrete.

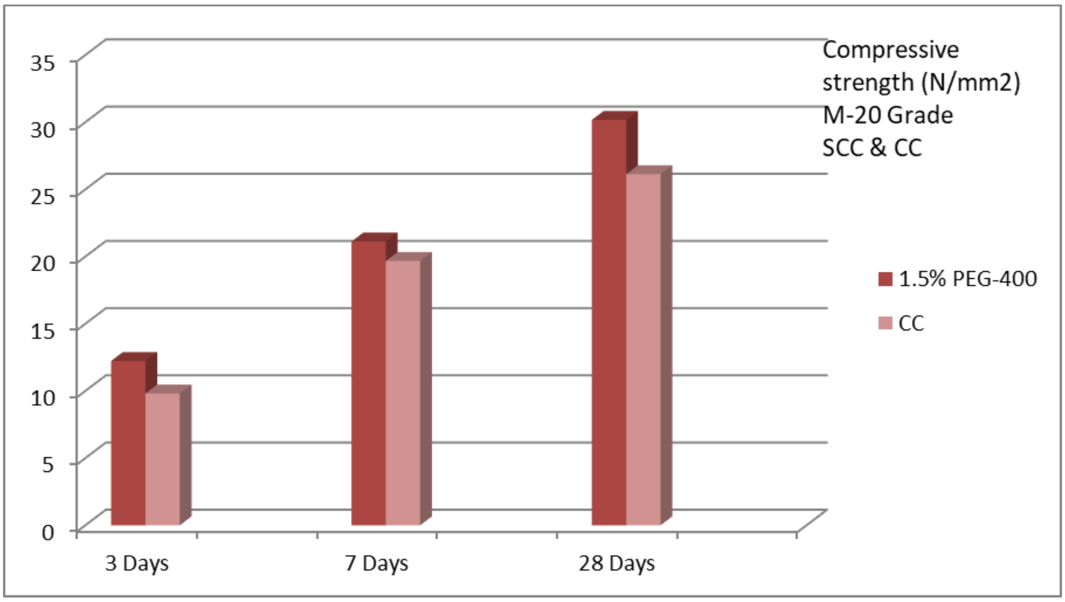

Figure 1. Comparison of Compressive Strength of M-20 grade in N/mm2 of CC and SCC (1.5% PEG)

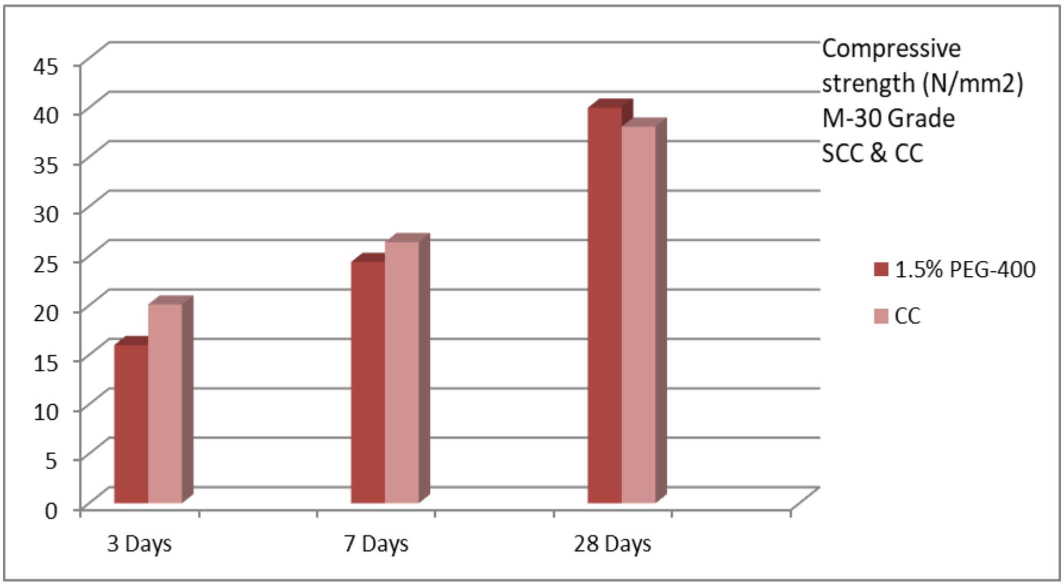

Figure2. Comparison of Compressive Strength of M-30 grade in N/mm2 of CC and SCC (1.5% PEG)

4.2 Split Tensile Strength Behaviour

The split tensile strength results mirrored the trend seen in compressive strength. As curing time increased, every concrete mixture demonstrated a steady rise in tensile strength. Concrete that self-cured with 1.0% PEG-400 showed better tensile performance than samples with other PEG-400 concentrations. The increased tensile strength could result from improved hydration and less internal shrinkage, both of which enhance bonding within the concrete structure. In the case of M20 grade concrete, the tensile strength of the optimal self-curing mix was nearly identical to that of conventionally cured concrete. The same trend was also seen in M30 grade concrete, though conventional concrete samples showed marginally higher values at later curing stages. The findings show that adding PEG-400 does not harm the tensile strength of concrete and can deliver strength levels similar to those from traditional curing methods.

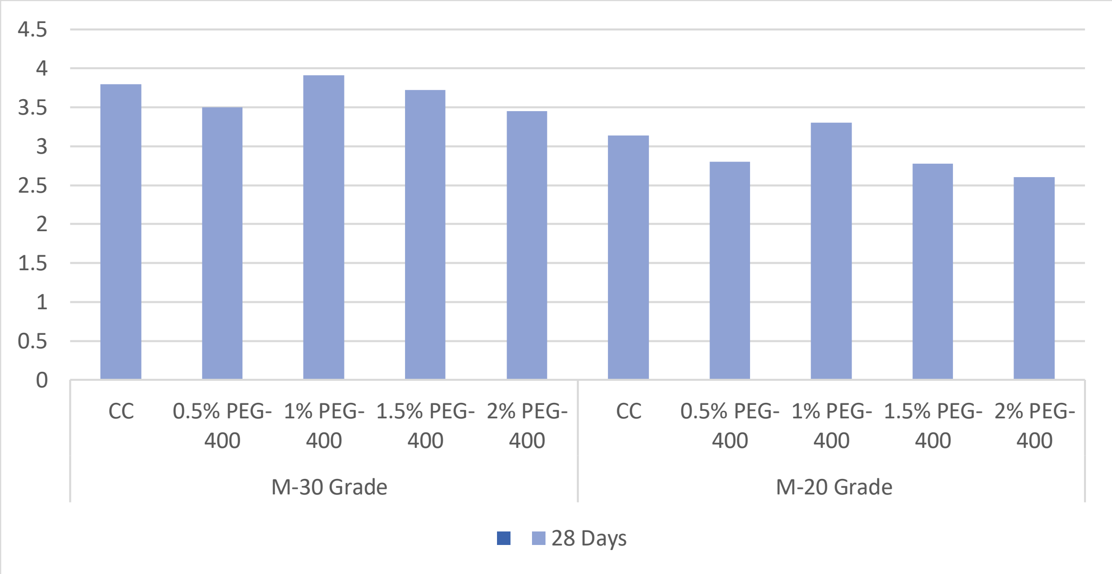

Figure 3. Comparison of Split tensile Strength of both grade in N/mm2 of CC and SCC

5. Conclusions

- Based on the experimental study comparing conventional concrete with self-curing concrete containing PEG-400, the following conclusions emerge Polyethylene Glycol-400 (PEG-400) acts as an effective internal curing agent, maintaining moisture within the concrete and aiding cement hydration without requiring ongoing external curing.
- Both standard concrete and self-curing concrete showed consistent growth in compressive and split tensile strength as curing time progressed, suggesting typical strength development behavior.
- The compressive strength tests showed that self-curing concrete with 1.5% PEG-400 outperformed all other tested mixtures for both M20 and M30 grades.
- The highest split tensile strength was observed in concrete mixes with 1.0% PEG-400, indicating that the ideal dosage for enhancing tensile performance might not align with the amount needed for peak compressive strength.
- The strength values from the optimal self-curing mixtures matched those of conventionally cured concrete, demonstrating that PEG-400 successfully sustains sufficient hydration.
- Using PEG-400 can greatly lessen reliance on external water for curing, making self-curing concrete a viable option for construction in areas with limited water access or where curing oversight is challenging.

- Internal curing technology has the potential to improve construction efficiency, conserve water resources, and contribute to sustainable concrete production without compromising the mechanical performance of concrete.

Overall, the study confirms that PEG-400 can be successfully utilized as an internal curing compound in concrete, with 1.5% dosage being the most suitable for compressive strength development and 1.0% dosage providing favorable tensile strength characteristics.

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